1127-13

Vol. VIII.—No. 36.] [MAY, 1888.

THE

MINERALOGICAL MAGAZINE

AND

JOURNAL

OF THE

Mineralogical Society.

INSTITUTED 3rd FEBRUARY, 1876.

EDITED BY A COMMITTEE OF COUNCIL.

Reprinted 1965 for
Wm. DAWSON & SONS LTD., LONDON
with the permission of
THE MINERALOGICAL SOCIETY

Mineralogical Society.

OFFICERS FOR 1887-88.

PRESIDENT.

L. FLETCHER, M.A., F.G.S.

PAST-PRESIDENTS.

H. C. SORBY, LL.D., F.R.S., &c. &c.

PROF. M. FORSTER HEDDLE, M.D., F.R.S.E.

VICE-PRESIDENTS.

THE REV. PROFESSOR HAUGHTON, M.D., F.R.S., &c. &c.

W. H. HUDLESTON, J.P., M.A., F.R.S., &c. &c.

COUNCIL.

A. GEIKIE, LL.D., F.R.S.
REV. H. GURNEY, M.A.
HUGO MÜLLER, Ph.D., F.R.S.
REV. W. W. PEYTON.
PROF. J. W. JUDD, F.R.S.
PROF. E. KINCH, F.C.S.
PROF. W. IVISON MACADAM, F.C.S.
J. J. H. TEALL, M.A., F.G.S.
PROF. A. H. CHURCH, M.A., F.C.S.
TOWNSHEND M. HALL, F.G.S.
J. STUART THOMSON.

TRUSTEES.

THE RIGHT HON. LORD DE BLAQUIERE, F.R.G.S.

PATRICK DUDGEON, F.R.S.E.

TREASURER.

THE REV. PROFESSOR T. G. BONNEY, M.A., D.Sc., F.R.S.

GENERAL SECRETARY, *pro tem.*

R. H. SCOTT, M.A., F.R.S.

FOREIGN SECRETARY.

T. DAVIES, F.G.S.

LOCAL SECRETARY.

Central Scotland—REV. W. W. PEYTON.

AUDITORS.

B. KITTO, F.G.S.

F. W. RUDLER, F.G.S.

EXCERPT MINUTES OF COUNCIL MEETING.

Held at 116 Victoria Street, February 28th, 1888.

The audited Balance Sheet for the year 1887 was submitted, and ordered be issued with the next Number of the Journal. (p. iii.)

GENERAL MEETING.

Held at the Museum, Jermyn Street, January 10th, 1888.

Mr. L. Fletcher, M.A., President, in the Chair.

Read the following letter :—

28 Jermyn Street, London, S.W.,
31st January 1888.

R. H. Scott, Esq., F.R.S.,
General Secretary of the Mineralogical Society.

Sir,—We desire to direct your attention to the enclosed circular (not inted here) relating to the next meeting of the International Geological ngress, which will be held in London from the 17th to the 22nd of ptember next.

We should be obliged if you would bring this matter before the Council d Members of the Mineralogical Society, with the view of inducing them attend the meeting if possible, or, failing that, to join the Congress as embers, and so to receive, post free, all Reports, Abstracts of Proceed-gs, and other publications relating to the London meeting.

During the week following the Congress there will be Excursions to tricts of especial geological interest, particulars of which, with detailed scriptions, will be sent to Members.

Trusting that the Members of your Society will assist the Organising Committee in making this meeting of the International Geological Congress a success,

We are, Sir,

Your obedient servants,

J. W. Hulke, } *General*
Wm. Topley, } *Secretaries.*

The following papers were read :—

"On the development of Lamellar Structure in Quartz Crystals by Mechanical Means." By Prof. J. W. Judd, F.R.S. (p. 1.)

"On the polysynthetic structure of some Porphyritic Quartz Crystals in a Quartz-felsite." By Col. C. A. McMahon, F.G.S. (p. 10.)

"Notes on Hornblende as a Rock-forming Mineral." By A. Harker, M.A., F.G.S. (p. 30.)

On the invitation of the President, Mr. Allan Dick, who was present as a visitor, made some remarks "on the process of Kaolinization," illustrated by models of crystals. (p. 15.)

The Secretary read a paper, communicated by Mr. Rudler, "Note on the occurrence of Celestite containing nearly fourteen per cent. of Sulphur," by H. J. Johnston-Lavis, M.D., F.G.S. (p. 28.)

Mineralogical Society—Abstract of Receipts and Payments from 1st January to 31st December, 1887.

RECEIPTS.	£	s.	d.
Balance from year 1886	8	16	6
Subscriptions in advance	1	6	0
„ for current year	76	11	0
„ Arrears	15	4	0
Entrance Fees	4	4	0
Sale of Publications	14	12	11
Dividends on Stock	5	19	8
Extra Copies of Publications	2	13	0
	£129	7	1

PAYMENTS.	£	s.	d.
Printing and Stationery	65	11	3
Illustrations	14	2	6
Expenses of Meetings	6	13	6
Editorial and Clerical Expenses	16	16	0
Postages, Parcels, &c.	10	2	10
Investments	5	19	8
Advertisements	1	4	6
Charge for keeping Stock of Publications and Insurance	5	9	0
Repairing Lock	0	2	0
Balance	3	5	10
	£129	7	1

Examined and compared with the vouchers and found correct. (Signed)

BENEDICT KITTO, } Auditors.
F. W. RUDLER, }

LIABILITIES.	£	s.	d.
Editorial Expenses, 1887	10	10	0
Clerical „ „	6	6	0
Subscriptions paid in advance	1	6	0
Williams & Strahan, Printing, &c.	6	12	0
Gas and Attendance at Meetings	1	11	6
Excess of Assets over Liabilities	247	6	11
	£273	12	5

ASSETS.	£	s.	d.
Subscriptions for 1887 unpaid	17	6	0
„ 1886 „	6	11	0
„ 1885 „	2	2	0
Entrance Fee unpaid	1	1	0
New 3 Per Cents. £210 4s. 9d. at 102½	215	9	7
Sale of Publications, Simpkin & Co.	10	13	0
Stock „ average yearly sale	17	4	0
Cash in hand and at the Bank	3	5	10
	£273	12	5

(Signed)

ROBERT H. SCOTT,
General Secretary.

Digitized by the Internet Archive
in 2023

https://archive.org/details/mineralogical-magazine_1888-05_8_36

THE MINERALOGICAL MAGAZINE

AND

JOURNAL

OF THE

MINERALOGICAL SOCIETY.

No. 36. MAY 1888. Vol. VIII.

On the Development of a Lamellar Structure in Quartz-crystals by Mechanical means.

By Professor JOHN W. JUDD, F.R.S.

[Read January 10th, 1888.]

As long ago as 1815, Brewster showed that many crystals have a lamellar structure developed in them by pressure,[1] and his observations became the starting point of a long series of very valuable researches. Reusch proposed that the planes along which such structures are developed by mechanical means should be called "Gleitflächen" (gliding-planes[2]), and he, Pfaff, and other mineralogists have investigated a number of curious cases of the kind. Baumhauer in 1879 showed that the lamellar structure could be brought into existence, in the case of calcite, by simply inserting a knife-blade in a definite direction into cleavage fragments of the mineral,[3] and his observations were confirmed in the following year by Brezina.

[1] *Phil. Trans.* 1816, pp. 156-178.
[2] *Pogg. Ann.* CXXXII. (1867), p. 441.
[3] *Zeitsch. Kryst.* III. (1879), p. 588.
[4] Ibid. IV. (1880), p. 518.

The investigations of many mineralogists, among whom may especially be mentioned Bauer and Mügge, have shown how universally such gliding-planes exist in all classes of minerals.

A few years ago it was shown that the lamellar structure so generally exhibited by the rock-forming felspars is really of secondary origin ; that it is developed in them as the result of internal strains produced by deformations of the crystal, arising either from unequal contraction or external stresses. This result was arrived at by J. Lehmann,[1] Van Werveke,[2] Foerstner,[3] and myself,[4] independently, and by different methods.

In a paper submitted to this Society in 1886 I have shown that the gliding-planes of crystals, after lamellar structure has been produced in them by mechanical means, become the planes along which chemical action most easily takes place ("solution planes" of von Ebner); and I have also pointed out the important bearings of the principle thus established in explaining the characters and modifications of many rock-forming minerals.[5]

Soon after Biot's discovery of the circular polarisation of quartz, Brewster showed that many amethysts exhibit a very remarkable lamellar structure, the alternate lamellæ consisting of right- and left-handed quartz.[6]

The structure of amethysts has been further investigated by Dove,[7] Haidinger[8] and Böklen,[9] who have confirmed and extended Brewster's early observations. On the ground of the peculiarity of its optical properties, Brewster proposed to divide the species amethyst from that of quartz, as had indeed been already suggested by Werner, but the subsequent discovery of equally complicated structures in almost all varieties of quartz-crystals has led mineralogists generally to refuse to acquiesce in this distinction.

Gustave Rose's memoir on the crystallisation of quartz[10] brought prominently before mineralogists the complicated effects produced by the

---

[1] *Untersuchungen über die Enstehung der altkrystallinischen Schiefergesteine.* Bonn, 1884, p. 196.

[2] *Neues Jahrb. für Min. &c.* 1883, II. p. 97.

[3] *Zeitsch. Krystall.* ix. (1884), pp. 333-353.

[4] *Quart. Journ. Geol. Soc.* Vol. XLI. (1885), pp. 354-358.

[5] *Mineralogical Magazine*, Vol. VII. (1886), p. 81.

[6] *Trans. Roy. Soc. Edin.* Vol. IX. p. 159. This paper was read Nov. 15th, 1819, but the observations on which it is based are said to have been made in 1817.

[7] *Darstellung der Farbenlehre* (1853), p. 251.

[8] *Sitzungsb. der Wiener Akad.* (1854), p. 401.

[9] *Neues Jahrb für Min. &c.* (1883), Vol. I. p. 62.

[10] *Abhandlungen der Akad. der Wissenschaften, Berlin*, 1844, p. 217.

urious intergrowth of two individuals in parallel but opposite positions;—henomena having such curious analogies with some of the appearances sually grouped under the name of twinning, but which are so difficult o bring under any definition of a law of twinning that can be suggested.

In the year 1855, two investigators, working independently and by ifferent methods, showed how complicated is the lamellar structure ften exhibited by different quartz-crystals derived from widely distant calities. Des Cloizeaux examined basal sections of quartz by the aid of olarised light, and obtained permanent records of their structure by hotographic means.[1] Leydolt exposed similar sections to the action of ydrofluoric acid, and showed that the patterns developed on the sections ndicate the molecular structure of the different parts of the crystal.[2] es Cloizeaux further showed that the lamellæ of right- and left-handed uartz are parallel to certain definite planes of the crystals, and that by eir overlapping they give rise to the interesting phenomena of Airy's pirals, when the sections are examined between crossed nicols in con-ergent light.[3] The principal planes parallel to which these lamellæ were und were those of R (100) and $-R$ ($\bar{1}22$). Of this interesting pheno-enon Des Cloizeaux was able to give a complete theoretical explanation.

In several recent papers Vom Rath has shown how the existence of mellæ parallel to the planes R (100) and $-R$ ($\bar{1}22$) are made obvious some quartz crystals, like those from Zöptau in Moravia,[4] and those om Burke County in North Carolina,[5] by striations on the prism faces the crystals, and also on some of the exceptional rhombohedral faces hich are developed in those crystals.

Into the difficult and somewhat vexed question of the theoretical inter-retation of the lamellar and other structures in quartz I do not propose enter. The general analogy of these lamellæ which are composed of ght- and left-handed quartz arranged alternately, to the so-called twin-mellæ of the plagioclastic felspars, of calcite, and of many other minerals, ust be obvious to every one; and there is a wonderful similarity in the rtial and irregular manner in which both are developed. In order to oid prejudging the theoretical question however, I avoid the use of the rm twinning with respect to the structures in quartz.

Up to the present time, so far as I have been able to ascertain, the

[1] *Ann. Chim. et Phys.* XIV. (1855), p. 129.
[2] *Ber. Akad. der Wissenschaften zu Wien.* XV. (1855), p. 59.
[3] *Loc. cit.* p. 286.
[4] *Zeits. fur Kryst.* V. (1881), p. 1.
[5] *Ibid.* X. (1885), p. 475.

lamellar structure in quartz-crystals has always been regarded as an original one, due to the peculiarities in the original growth of the mass. Without for one moment asserting that such structures may not be original in some quartz-crystals, I propose to describe a case in which it is possible to show that these lamellæ of right-handed and left-handed quartz are as clearly of secondary origin, and as certainly due to the action of mechanical forces upon the crystals, as are the analogous structures found in the felspars and in calcite.

A fine crystal of smoky-quartz from an old collection was found to exhibit upon its exterior surface peculiarities which seemed to indicate that it was deserving of further investigation. The label indicating the original locality of the crystal was unfortunately lost, but it so greatly resembles the smoky-quartz from Miask in the Urals, that I have little doubt that it came from that locality. The crystal is a large one, a circle circumscribing the hexagonal equatorial section having a diameter of 7·4 centimetres, and the length of the crystal from its apex to the irregular fracture forming its base is 12 centimetres. The surface of the crystal indicated that it had undergone a considerable amount of bruising and other mechanical injury, probably from movements in the rock-mass in which it had been enclosed.

Fig. 1.—Crystal of Smoky-quartz exhibiting natural etchings on its rhombohedral faces. (One-half natural size.)

The rhombohedral faces of the crystal are very unequally developed, one of the R (100) faces and a $-$ R ($\bar{1}22$) face lying side by side attaining large dimensions, and the other faces being proportionately reduced. The

crystal was at first seen to be covered by a deposit of carbonates and hydrous ferric oxides, and it was only upon the removal of these by the action of hydrochloric acid that the very beautiful surface characters of the crystal were fully revealed. (See Fig. 1.)

It was then seen that the faces had undergone a most beautiful process of natural etching, whereby the limits and mode of penetration of the two individuals of which it was composed became clearly manifested. The portions of the two individuals in the R and — R faces respectively showed the most striking differences in lustre; and on examining the surfaces with a lens, it was seen that this difference of lustre was due to diversities in the pattern of rhomboids developed upon the portions of the two individuals in the two rhombohedra. The portion which was dull on one rhombohedral face became bright in passing into the rhombohedral face by its side, and *vice versâ*. This is an appearance which has frequently been described as occurring in quartz-crystals, but the present example is finer than any that has before come under my notice.

In order to determine the nature of the individuals composing this quartz-crystal, a section was cut from it at right-angles to the principal axis, and examined in a polariscope with convergent light. By this means it was shown that the two individuals combined in the crystal both consisted of *left-handed* quartz, but here and there the section was found to exhibit the interesting phenomenon of Airy's spirals.

The next step in the investigation of the crystal consisted in etching a section cut at right angles to the principal axis, and the results which were thus obtained were of the very highest interest.

The distinction between the two individuals of which the crystal was built up came out in the strongest relief, the etching-figures produced by the action of the acid being in opposite positions, so that when one set reflected light and became bright, the other set were dull, and *vice versâ*. It was then seen how complicated was the intergrowth of the two individuals, small hexagons of the one individual appearing actually enclosed in the other. In spite of the irregularities, however, there was clearly seen to be a tendency to parallelism between the planes dividing the two individuals and the bounding faces of the crystal. (See Plate I., fig. 1.)

But in addition to the division of the section of the crystal between two individuals, it was found that, in certain parts of the section, alternating lamellæ made their appearance, these lamellæ having a wonderful resemblance to those found in plagioclastic felspars. They were seen to be sometimes broad, sometimes narrow. They were found to run irregularly into the crystal and stop suddenly short; and it was moreover seen that

there were two sets of these lamellæ intersecting one another at angles of 60° and 120°. In photographs of these sections which were kindly prepared for me by Mr. Chapman Jones and Mr. A. E. Tatton, of the Normal School of Science, these peculiarities come out in a very striking manner.

Further examination of the section proved two very important facts.

First.—The portions of the section *a* and *b*, where these lamellæ make their appearance are just those in which, under convergent light, the Airy's spirals are seen. The lamellæ are thus proved, as Des Cloizeaux has shown, to consist alternately of right-handed and of left-handed quartz which overlap one another.

Secondly.—The lamellæ are only developed where the crystal has suffered injuries, and in many cases the lamellæ can be seen running up to and stopping short at a crack which traverses the crystal.

On examining one of the prism-faces of the crystal (Plate I., fig. 2) the evidence derived from the study of the section at right angles to the principal axis received remarkable confirmation. In its natural state, this face only exhibited the usual striations parallel to the basal plane, interrupted by the irregular line which marked the junction of the two individuals of left-handed quartz. In addition to this the crystal was seen to have undergone a certain amount of mechanical injury, a number of irregular cracks intersected some parts of the crystal, while here and there a number of curved cracks marked the incipient development of the conchoidal fracture.

When this prism-face was carefully etched with hydrofluoric acid, however, a most interesting series of phenomena was displayed. Two sets of lamellæ, very irregularly developed, were seen intersecting one another nearly at right angles. Upon making a drawing with the camera lucida and measuring the angle carefully with a protractor, the position of the planes and their angle of intersection were found to be parallel to those of R (100) and $-R$ ($\bar{1}22$) in the crystal.

The parts of the crystal which had not suffered injury were found to be free from these lamellæ; but where injury had taken place these lamellæ were developed in a most striking manner. Moreover, it was clearly manifest upon a careful examination of the specimen that *the lamellæ in many cases ran up to and stopped short at an accidental crack*, in just the same manner as I have shown to be the case in the plagioclastic felspars.[1] These facts are very strikingly seen in the etched surface of which a drawing is given in Plate I., Fig. 2.

[1] *Quart. Journ. Geol. Soc.* Vol. XLI. (1885), p. 365, Pl. X., Fig. 1.

The very important conclusions which may be deduced from these observations are as follows:—

1. Quartz must be added to the list of minerals in which a lamellar structure can be developed by mechanical means.

2. The gliding-planes of quartz-crystals are those of R (100) and $-R$ ($\bar{1}22$).

3. In quartz, as in calcite, the felspars and other minerals, in which a lamellar structure has been developed by mechanical means, the gliding-planes become the planes along which easiest chemical action takes place ("solution-planes").

The curious and very interesting circumstance in the case of quartz-crystals is that the lamellæ developed in them by mechanical action are not distinguished as in the case of calcite or felspar by exhibiting an opposite polarity in the molecules composing the alternating lamellæ, but by a *reversal of the direction of their circular polarisation*. That this reversal of the direction in circular polarisation can thus be effected by mechanical means is certainly a very startling fact. The analogy between the lamellæ of right and left-handed quartz and of the lamellæ of calcite or felspar with opposite polarity is a very striking one, and the fact that the definite planes in the crystal, along which the change takes place become planes of easy solution is also very remarkable. The claim of these lamellar structures, now shown to be of secondary origin, to be regarded as *twinning*, is one to be settled by crystallographers.

It is the circumstance that the gliding-planes of a crystal, after the lamellar structure has been set up in it by the action of a mechanical force, become the "solution planes," that enables us to trace the remarkable change which takes place in quartz-crystals.

The interesting observations recently made by Prof. J. Lehmann upon 'Contractions-risse,'[1] taken in conjunction with my own results, suggest that the so-called "cleavage" of quartz, produced by heating crystals and plunging them into cold water, is really due to a yielding of the crystals along the *gliding* planes, and not to any true cleavage along the rhombohedral planes. Prof. Lehmann's observations show that the 'Contractions-risse" are sometimes produced along cleavage-planes, and at other times along gliding-planes. This being the case, and my own demonstration of the fact that quartz has gliding-planes parallel to R (100) and $-R$ ($\bar{1}22$) being taken into consideration, it is fair to

[1] *Zeitschr. fur Kryst.* &c. Vol. II. (1886), p. 608.

conclude that the supposed cleavage of quartz is not really such, but is due to the yielding along the now demonstrated gliding-planes.

The brittle and intractable character of quartz has hitherto foiled my efforts to produce these lamellar structures at will, either by crushing or percussion, or by alternate heating and cooling; methods which have yielded such very interesting results in the case of calcite, the felspars and many other minerals. I am, however, still continuing my experiments in this direction.

In studying a number of quartz-crystals I find that the irregular lamellæ are sometimes developed in certain parts of zoned-crystals in a manner strongly suggestive of the structure having been originated by irregular contraction in the crystal. The further consideration of this and many other very interesting questions must be postponed to a future occasion.

A very interesting question which suggests itself to petrologists in connection with this question is that of the existence of lamellar structure in the quartz of various rocks, and how far such a structure, if it exists, may be regarded as the result of the mechanical stresses to which the rocks have undoubtedly been subjected. In order to determine this problem, I have prepared sections of various rocks, especially those in which the felspar exhibited much complicated twinning in the case of plagioclastic felspar or of microcline structure in the orthoclase felspars, and have submitted them to etching. The results which I have yet obtained however, are of a negative character. The pressure which has produced the twin-striations in the felspars seems in most cases to have actually crushed the quartzes, so that a polysynthetic structure was the result.

In making the observations upon which this note is founded, I have been very greatly indebted for kind advice and assistance to our President, Mr. L. Fletcher, and to Mr. H. A. Miers.

DESCRIPTION OF PLATE I.

Fig. 1.—Section of smoky-quartz crystal at right angles to the principal axis, which has been etched with hydrofluoric acid, magnified 1½ times. The parts shaded light and dark respectively show the portions belonging to the two individuals (*both* of *left*-handed quartz) compounded in the crystal. The boundaries of the two portions, though often very irregular, exhibit a tendency to parallelism with definite planes in the crystal, small hexagonal patches of one individual lying within the limits of the other. At two points, *a* and *b*, groups of lamellæ are well seen, and that these consist of alternations of right- and left-handed quartz is shown by the fact that Airy's spirals are exhibited at those portions of the crystals. The general disposition of the cracks that traverse the crystal is shown by the sharp black lines.

Fig. 2.—Portion of a prismatic face of the same crystal also etched with hydrofluoric acid, and magnified 3 diameters. Where, as at *c*, the crystal has suffered a considerable amount of mechanical injury, indicated by the curved conchoidal cracks and the longer incipient fissures extending through it, the lamellar structure parallel to R (100) and $-R$ ($\bar{1}22$) is admirably developed; but where, as at *d*, the crystal is uninjured, there is a total absence of the lamellar structure. The dependence of the lamellar structure on the mechanical forces which have produced cracks in the crystals is placed beyond doubt by the fact that some of the lamellæ stop short at artificial cracks, in just the same manner as is the case with the twin-lamellæ of felspars.

On the Polysynthetic Structure of some Porphyritic Quartz Crystals in a Quartz-felsite.

By Major-General C. A. McMahon, F.G.S.

[Read January 10th, 1888.]

BEFORE describing some features of special interest in the micro-porphyritic quartz crystals of an Indian felsite, it may be as well to say a few words, by way of preface, regarding the rock itself.

About 85 miles to the north-west of the town of Delhi, in the peninsula of India, a hill rises abruptly from the plain to the height of 630 feet. It is one of a series of similar elevations separated from each other by some miles of sandy soil which strike the traveller with their resemblance to a group of islands in a tempestuous sea—an idea greatly favoured by the long swelling waves into which the sand is thrown by the strong westerly winds which prevail in that region during the greater part of the year.

The dip of the rocks of which the hill of Tushám is composed is nearly vertical; those on the eastern flank consist of chiastolite schists; and they are succeeded, as you proceed towards the west, first by pale grey argillaceous beds traversed in all directions by bright red ferruginous bands, and then by felsites that compose the centre and western side of the ridge.

Granite and quartz-porphyry intrude into the felsites at different points, and a granite-porphyry, that closely approximates to a true granite, forms the substance of neighbouring hills.

Some 250 miles and more to the south-west of Tushám Dr. Blanford some years ago discovered felsites in Bálmir, in some respects resembling those of Tushám, which are associated with beds of unmistakable volcanic ash.

The Malláni beds of Bálmir, and the felsites of Tushám, are probably rocks of extreme antiquity; but as they occur in isolated outcrops their precise age in both cases is unknown.

In the thin slices of one of the Tushám felsites several of the porphyritic quartz crystals when examined between crossed nicols present the tessellated appearance peculiar to the polysynthetic structure, being made up of

countless quartz grains of microscopic size. These crystals are set in a structureless felsitic groundmass.

The porphyritic quartzes of the felsites and quartz-porphyries of Tushám are corroded in the way familiar to the student of rocks of this class. In some, the original outline has been more or less completely destroyed; in a few the crystallographic form has remained nearly intact; whilst in others the outline is partly sharp and partly blurred. Some crystals seem to have been on the point of disappearing altogether; some have had their corners rounded off and part of their substance eaten away, whilst some have only yielded here and there; fragments of free quartz, in the last mentioned cases, however, seem to have been on the verge of being floated off from their parent crystals when the process of re-solution was arrested by the cooling and consolidation of the rock.

The polysynthetic structure of these quartz-crystals is not the only point to be noted in them. The crystals that exhibit this structure appear to have been extensively schillerized. Red and brown oxides of iron, and other material, have been freely introduced, and numerous strings of a flaky colourless substance, that I believe to be a species of mica, have been formed in them.

It is noteworthy that these wavy strings, though not exactly parallel to each other, maintain a common direction within each quartz-crystal undisturbed by the micro-grains into which it is subdivided. In one of the members of a group of crystals the micro-grains of quartz show a disposition to elongation in the same direction as the micaceous strings. I have attempted to show this in my plate; but as regards the exact shape of the micro-grains depicted therein I do not pretend to minute accuracy.

Dr. Sorby in one of his classical papers stated that "the quartz of thin-foliated gneiss and mica-schist differs from that of granite in having a far less simple optical structure, and in being often more or less flattened in the plane of foliation. Instead of the larger portions of quartz being made up of a few comparatively large crystals, they are frequently composed of very many, closely dovetailed together, as if formed *in situ*."[1] Other petrologists have gone even further, and apparently accept the polysynthetic structure as evidence of a metamorphic in contradistinction to an igneous origin. The latter conclusion is, I venture to suggest, an erroneous one. Micro-granules of quartz are no doubt characteristic of schists, but they are not confined to rocks of clastic origin. The eruptive

[1] *Q. J. G. S.* Vol. XXXVI., Anniv. Address, p. 48.

granites of the Himalayas, to the study of which I have devoted some time in past years, abound in polysynthetic grains of quartz. If the canon of interpretation alluded to were to be applied to the crystals now in question, we should have to regard these quartz-crystals as fragments of schists included in the felsite. The strings of micro-crystalline mica might seem to support this contention; but an advocate of this theory would, I think, find some difficulty in accounting for the striking crystallographic outlines of these fragments. Some petrologists, on the other hand, appear to consider the presence of polysynthetic structure in quartz as evidence of mechanical pressure; and when they see quartz grains elongated in the same general direction, they regard the circumstance as an indication of plastic deformation. But, in the case before us, all argument regarding plastic deformation seems to be put out of court by the fact that the Tushám rocks give no evidence of crushing either in the field or under the microscope. None of these felsites, or the granites in their neighbourhood, give the least indication of even incipient foliation.

The polysynthetic structure of these quartz-crystals must be accounted for in some other way than by an appeal to plastic deformation.

The inclusion of portions of the groundmass in the porphyritic crystals of quartz-porphyries has long been recognised as a characteristic of rocks of that class; and the explanation given by M. M. Fouqué and Michel Lévy, in their *Minéralogie micrographique* is, that these quartz-crystals were formed in the magma in an early stage in the history of the rock, and subsequently underwent partial re-solution.

Evidence that the inclusion of portions of the groundmass in the quartz crystals of the Tushám quartz-porphyry was not, like the glass inclusions in the minerals of some lavas, due to the entanglement of the base consequent on rapid cooling after the eruption of the rock, but that it was due to corrosion, is, I think, furnished by the Tushám rock itself. "The matrix," to quote from one of my Indian papers,[1] "of a hand specimen taken from the thin tongue protruded" from the main dyke "into the adjacent rocks is perfectly compact, even when viewed with a powerful pocket lens, whereas that taken from the body of the dyke appears, under the same lens, to be micro-granitic rather than compact—a difference attributable, I presume, to the fact that the thin tongue cooled more rapidly than the main dyke. If the porphyritic crystals were formed after the intrusion of the quartz-porphyry, one would expect to see a marked difference between those in the tongue and those in the main dyke, correspond-

[1] *Records Geol. Surv. India*, Vol. XVII. p. 108.

ng to the difference observable in the matrix of the specimens from the wo localities. One would, also, expect to see inclusions of the groundmass nore common, and crystallographic outlines less frequent in the former han in the latter. No such difference, however, is to be discerned. Sharp, vell-defined crystallographic outlines are not rare in the quartz of the pecimen from the tongue; whilst the crystals in the main dyke are quite s much corroded as any in the tongue."

The commonly accepted explanation of the cause of the inclusion of portions of the groundmass in the quartz of quartz-porphyries suggests, think, an explanation of their polysynthetic structure. These crystals vere, I suppose, formed whilst the uncooled igneous rock was at rest elow the earth's crust. Movement towards the surface then took place, robably in connection with volcanic action; pressure was relieved; the nelting point was consequently lowered, and a re-melting or re-solution of e porphyritic crystals commenced. The first stages of this process onsisted in the schillerization of the quartz-crystals. Extraneous mineral natter penetrated from the matrix into the quartz-crystals along "planes f chemical weakness," to borrow the admirable term used by Professor udd, and the ferruginous patches and flakes and strings of mica now to e seen[1] in them were introduced. In the gradual progress of the magma pwards, pressure was still further relieved, and the tendency to re-melt as increased. Some of the crystals appear to have nearly succumbed to is influence and to have been almost completely assimilated—remnants f them, however, may I think be still detected in patches here and there. ome crystals yielded less readily than others, and in the case of those nder description the process of re-melting was suddenly arrested by their aving been poured out on the surface, or moved into a position between mparatively less heated rocks, where the process of cooling and consoli- ation set in.

A rapid transition from a condition of heat verging on the melting oint to one in which the loss of heat was rapid, must have caused con- derable internal strain; and it is to this internal strain at the moment consolidation that I attribute the formation of the polysynthetic struc- re of the crystals now exhibited.

Another explanation may be suggested. It seems possible that this ructure may be an indication of the commotion into which the molecules quartz were thrown, and the breaking up of old ties which took place hen the melting point was almost reached, but I incline towards the rst explanation.

[1] As the polysynthetic structure and the schillerization could not be shown together without confusion, I have not attempted to illustrate them.

I may mention in connection with this subject, that I have specime of complex felspar crystals, or rather groups of crystals, which occur in lava from the crater walls of Monte Somma, Naples (collected by myself which may, I think, be explained in the same way. Sections of these co pound crystals in thin slices under the microscope are lozenge-shape though the outer boundary of each lozenge is broken by the projecting en of minute felspar crystals. These felspar corporations appear to ha originally grown as single bodies, for they exhibit along their outer margi a strongly developed zonal structure, and contain countless inclusions devitrified glass arranged in elliptical lines in symmetry with the ou shapes of the lozenges. Notwithstanding these symmetrically group "stone" inclusions and the zonal lines, however, each lozenge is su divided into a great number of minute felspar crystals, many of which a visibly triclinic. These micro-crystals do not interfere with the symm trical allignment of the bands of devitrified glass, and consequently ea corporate body, with its corporate symmetry, must have been form before it was broken up into these minute crystals of felspar. On the oth hand, the fact that the unbroken ends of these micro-crystals project in the magma, indicates that the modification of internal structure impos on those corporate bodies subsequent to their formation, took place wh the rock was still in a plastic condition.

EXPLANATION OF PLATE II.

Fig. 1. A rounded and corroded quartz-crystal subdivided into sev quartz-grains oriented in different directions. These grains are, with o exception, directly related to the outlines of the internal corrosions. T only exception is the large inclusion of the groundmass seen in the cent of the largest micro-grain.

Figs. 2, 3, 4, 5, 7, 8, are illustrations of corroded quartz-crystals th are not subdivided into micro-grains.

Fig. 6. Porphyritic quartz compounded of several quartz-crystals, ea of which is subdivided into numerous micro-grains of quartz, the op axes of which are oriented in different directions. The crystals are co roded in places, and portions of the substance of the quartz seem to ha been on the point of floating off into the magma when the rock began cool and consolidate. The thin slices contain other similar crystals whi are not represented in the plate. Some of these present sharp crystal graphic outlines; others have completely lost their shapes and seem the point of being absorbed into the matrix.

On Kaolinite.

By Allan Dick.

(Communicated by J. J. H. Teall, M.A.)

[Read January 10th, 1888.]

I PROPOSE to add one more account to those which have already been published of this mineral. It is described as a rhombic mineral in Dana's Mineralogy and other standard works. Latterly it has been described by Reusch as an anorthic mineral, from National Belle Mine, Red Mountain, Colorado, in the *Jahrbuch für Mineralogie*, 1887, Bd. II. Now I describe it as monoclinic, principally from a study of that variety of it which occurs in Anglesey, of which an account was published by Dr. Percy in 1875 in his Metallurgy, Vol. "Fuel." The mineral had been analysed in his laboratory by Mr. Tookey, who found it to have the following composition:—

Silica	46·53
Alumina	38·93
Water	14·54
	100·00

Corresponding to the formula Al_2O_3, 2 SiO_2 2 H_2O. As the water had been estimated by difference, I recently determined the actual loss on ignition. Dried at 100° Cent. the loss amounted to 0·21 per cent., and it suffered no further loss of weight in an air bath heated to 275° Cent. At a red heat the dried mineral lost 13·87 per cent., and nothing further at a heat approaching whiteness.

Dr. Percy says, at page 96, Vol. "Fuel," "I have received (May 27, 1871) from my friend, Mr. Thomas F. Evans of Amlwch, the following precise information concerning the locality and mode of occurrence of the kaolinite from the Isle of Anglesey. Between Bull Bay and Small Bay further west, in the vicinity of Amlwch, is a place called Porth-yr-hwch, very near which a level was driven many years ago from the sea-level with a view of proving a lode of quartz-rock containing small specks and strings of copper pyrites which show on the land above. It has been driven as nearly as he could measure in the water—for the work has been abandoned for years—about 83 fathoms. There are near the end two or

three short bits of level driven east and west, and in one of those going west occurs the mineral in question. The fore breast in this level is a bluish and rather hard slate, having veins of quartz running through it, and there are several small cavities which occur in the line of the quartz veins, and appear to be parts of those veins: some of the cavities are lined with a rather hard crystalline substance, and others contain the crystallised kaolinite. This level is driven through clay slate, but there is a band of hard rock of an Elvan character between the lode and the sea shore. (The word *Elvan* is Cornish, and is applied to particular rocks, more or less porphyritic, occurring in Cornwall.)"

The bulk of the mineral consists of hexagonal plates, amongst which are a few rhomboidal ones. Until it is examined under the microscope it might be mistaken for powdered starch. It is a white glistening powder. It remains suspended in Sonstadt's solution of the density 2·62, as I found by careful trials made at the temperature of 60° Fahr. That, therefore, is its density. The mineral, washed from small, generally doubly terminated crystals of quartz and rhombs of calcite or dolomite, which are sparsely distributed through it, scratches selenite with ease, and muscovite with difficulty. It does not scratch calcite, so that its hardness is about 2·7. It is scarcely attacked by boiling hydrochloric or sulphuric acid unless previously finely ground, and even then only very slowly. The crystals dissolve slowly but completely in hydrofluoric acid, diluted with its own bulk of water, and the powder in weaker acid.

Its refractive index is about equal to that of Canada balsam, and its double refraction rather less than that of quartz. I have not been able to determine the character of its dispersion in convergent polarised light, owing to the small size of the crystals. The largest I have met with produced a retardation of only a half wave length between the two rays into which a ray of polarised light is divided after passing through the crystal at 45° to the plane of polarisation, so that no rings could be seen, only the parabolic curves. These passed out of the field of view during the rotation of the section alike when the positive and negative bisectrices were being examined, so that I could not determine which is the acute bisectrix. This observation was made with a $\frac{1}{2}$-inch objective of the highest possible angle, immersed in oil.

EXPLANATION OF THE FIGURES ON PLATE III.

Fig. 1.—Five compound tabular crystals to illustrate the appearance of kaolinite from Anglesey, when seen through a microscope, magnifying about 130 diameters: the drawings were made by the help of a camera lucida. The crystals consist of hexagonal and rhomboidal plates, often excessively thin, arranged one upon another so that the compound crystal becomes thicker by steps. Each successive plate is smaller in certain directions, and sometimes in all directions, than the plate immediately beneath it, but the top plate is frequently much thicker than the others. The plates are represented as lying on their basal planes in the position of extinction between crossed nicols, the diagonals of which are supposed to be parallel with the edges of the sheet of paper.

In this kaolinite there does not seem to be any cleavage parallel to the lines bounding the superimposed plates. When an attempt is made to develope a cleavage by thrusting a needle through the compound crystal, it bends and breaks with ragged edges, as shown in the upper right-hand corner of the largest crystal. The sides of the superposed plates are true facets. Beneath the five figures are two diagrams intended to show crystals like those above, cut parallel to the clinopinacoid, extinguishing about 20° on one or other side of the cross wires of the eye-piece. The diagram on the left hand, where the plates are seen diminishing above and below the largest plate, is very rarely met with: the common form is seen on the right hand. They seem to point to the building up of crystals, such as fig. 14 and fig. 4. The plates are too thin to be drawn to scale, and are therefore shown as a diagram.

Fig. 2.—Cleavage plates of kaolinite produced by pressing the crystal shown in fig. 8 between the glass slip and cover till the crystal broke up with a crack. Some of the bottom plates have detached themselves. I counted between 70 and 80 plates, but many of them were compound. The bottom plate, for instance, consisted of 11 plates, but so little shifted in position as to appear like one plate, as here drawn. These cleaved plates differ from the immense majority of the natural plates in being each of uniform thickness. They are often so thin as to exert no appreciable effect on polarised light. The thinnest plates I reckon do not exceed the 40,000th of an inch.

The drawing, although made by the means of the camera lucida, is not quite correct where the detached plates meet the pack of almost unshifted plates. There the lines seen through the plates are with difficulty distinguished from those above, and have been left out so that the drawing

may be simplified. The drawing is magnified about 130 diameters, and it will be seen that the crystal has about doubled in length by being broken up. It is a beautiful example of cleavage, and may be repeated on any crystal lying on its side.

Fig. 3.—The crystal from which fig. 2 was produced. It was water-clear and free from visible cleavage planes: magnified by about 130 diameters, drawn by the aid of the camera lucida as it lay on its side, *b*. The forms of the top and bottom were got by turning the crystal over in water under the microscope, and adding the shapes to give solidity to the camera tracing. The angle in the lower left-hand corner was about 80°: that in right-hand corner about 76°. These angles in perfect crystals are nearly constant, the limits which I have found being from 80° and 76° to about 83° and 79°. They do not quite agree with the angles found by reflections on a goniometer by Mr. Miers. I suppose this may be due to the tendency of the mineral to build itself up in steps, as shown in subsequent figures. The edges and faces seen under high powers are never quite perfect. The edges waver a little, and here and there steps are seen, which, if frequent enough, though ultra-microscopical, would produce the result, but would not affect reflections. When such a crystal is mounted, so that it can be rotated in oil round an axis at right angles to the basal plane, it is found to give the maximum angle of extinction about 20° from the vertical, on one or other side the upright cross wire, according to which side of the clinopinacoid the observer looks through. It then shows the emergence of a well-marked positive bisectrix in convergent polarised light. There does not appear to be much difference in the apparent angle of this bisectrix and that of the negative one emergent from the basal pinacoid, so that the angle must approach a right angle. As the crystal is rotated between crossed nicols, the angle of extinction diminishes till straight extinction is reached, when the observer is looking along the direction of the clinopinacoid, which, therefore, must be the plane of symmetry.

Fig. 4.—A crystal somewhat similar to figure 3, but showing a few cleavage planes and internal markings: magnified about 75 times. It is the largest crystal I have met with, being a little more than the hundredth of an inch in height. I have figured it as seen looking through the clinopinacoid in the reverse position to that of figure 3, so as to show the direction of extinction reversed. The more acute angle formed by the basal plane and the pyramidal-looking sides is now at the left-hand lower corner, and from its position the extinction in any crystal can always be foretold. Finding the angles 80° and 76°, or thereabouts, very uniform, I thought

he sides might be the ±P of a half monoclinic octahedron; but Mr. Iiers informs me, as the results of his measurements, that the crystal can e better defined if the left-hand sides of fig. 3 are regarded as composed f two prism faces and the right-hand side of two pyramid faces, which is eversed in fig. 4. It will be seen in fig. 4 that one prism and one pyra- nid face is reduced to very small dimensions, with the result that when he crystal is broken up into plates, as in fig. 2, there will be produced op plates, having the optic axial plane along the greatest length of he plate (fig. 5), and bottom plates in which the same plane is at right ngles thereto.

Figs. 6 and 7.—A very curious crystal, over which I spent much time efore I could understand it. I turned it over and over in a drop of ater under the microscope, so as to inspect each face and find its positions f extinction, shape, &c. It will be seen that there are two faces, one n the prism, and the other on the pyramid side, which taper to a point, iving rise when the crystal is split, as in fig. 2, to a rhomboidal plate at ne bottom, and an hexagonal plate at the top. Fig. 7 is fig. 6 looked own upon in the field of the microscope. I have seen crystals of mica hich appear to have the same form, but what the triangular face is I do ot know. Possibly it may be a combination of the prism and an obtuse yramid, the steps not being visible. When I had the crystal I did not now that such small ones could be measured on a reflecting goniometer. broke the crystal first into 5 plates by pressure, and then into a larger umber by increased pressure. I have not found another so perfect, but any with a few steps in the triangular face. If composed of the prism nd pyramid I suppose it should give two images on a reflecting gonio- eter. Drawn by eye. Magnification not known, perhaps 100 times.

Fig. 8.—A portion of a crystal like fig. 3, after being heated to redness expel all water. The crystal swells much, and becomes opaque. rawn by means of the camera lucida.

Fig. 9.—A crystal like fig. 3, in which the prism edges are truncated the top by what appear to be two pyramid faces inclined from 40° to 5° to the horizon when the basal plane is parallel to the horizon. Drawn y eye from a model in wood made from drawings through the camera ucida. The M.m. faces seen in front extinguish about 4° or 5° on alter- ate sides of the cross wires. When immersed in Canada balsam, so as allow the light to pass exactly along the clinopinacoid (thus practically olishing both M.m. and N.n. faces), the crystal gives a straight extinc- on. Having almost the same refractive index as Canada balsam, the

observer seems to be looking through the faces of the orthopinacoid, though it is not present in the crystal under observation.

In reference to the above-named angle of 40° to 45° (for it seems to vary in different crystals), it must be remembered that angles measured from drawings through the camera lucida of this mineral always differ from the angles measured on a goniometer, owing, I suppose, to minute steps in the building up of the faces. These steps can often be seen excessively small, even under high power.

Fig. 10.—A crystal in which the M.m. faces seem to have been suppressed, or it may have arisen from the natural cleavage of such a crystal as No. 9, the top part forming No. 10, and the bottom part No. 8. Looking down upon it and through it on the field of the microscope to a scratched surface beneath, the scratches are seen through the basal plane, but not through the sloping sides. The crystal shows three partial cleavage planes and one internal line parallel to the more sloping face.

Fig. 11.—A crystal similar to the preceding, but prolonged upwards into a crystal like fig. 4. One or two partial cleavage planes are visible, and there are one or two steps in the angle where the right-hand faces join. As a rule, such crystals have a curved surface at the point of junction, and generally steps are visible thereon: magnified about 75 diameters, and drawn by the help of the camera lucida.

Fig. 12.—A long flat crystal to illustrate the manner in which one or other of the pyramidal looking sides is sometimes set back in steps. In trying to separate the crystal from others among which it lay on the field of the microscope for the purpose of mounting it, to measure the position of extinction between crossed nicols, and determine which faces are set back here in steps, the crystal was lost, but from other crystals it seems that either M.m. or N.n. faces may be so set back. When such a crystal is mounted on a glass slip with a scratched surface, the scratches can easily be seen through the crystal, even when the steps are very close together. This crystal is the most extreme instance of setting back which I have seen, and it is confined to one side. It will be noticed that the line joining the hexagonal plates on the left-hand is not a straight line as in the more perfectly developed facets on the right-hand, but this is only a matter of degree. The line, so far as I have seen, examined under a high power (say 500 diameters) always wavers a little, so do the edges of the clinopinacoid, and I have noticed the same thing in quartz and other crystals when they looked perfectly true to the unassisted eye. Magnified about 130 times, and drawn by the help of the camera lucida.

Fig. 13.—The same crystal as it would appear seen on its edge, but I have not attempted to represent the steps.

Fig. 14.—Shows the manner in which two crystals, such as Fig. 3, combine. They extinguish between crossed nicols as one crystal. In this case the lower one is one-twentieth part longer than the upper and a trifle thicker. The latter point is much exaggerated in the drawing to make it visible. A distinct cleavage-line always separates the two halves: otherwise they look like a true oblique octahedron modified by the clino- and basal-pinacoids: magnified about 100 times.

Figs. 15, 16 and 17.—Other examples of similar grouping, but in which the relative size of the two halves is very varying. In fig. 17 a crystal like fig. 10 is mounted on a thick plate, to which a crystal, like that of fig. 3 turned round and over, is attached. The fitting at the edges is not quite so perfect as is here drawn, and there are many cleavage planes and a few steps near the points of junction. These have been omitted in order to render the grouping more clear.

Fig. 18.—A crystal which is the only one of its kind I have yet seen. The right-hand side is formed by the clinopinacoid. In front the M.m. faces are replaced by three faces, of which the central one rises at a small angle from the basal plate. If the M.m. faces are regarded as prism faces it is the orthopinacoid. I have not seen it developed in any other crystal. The lateral faces are slightly curved and much more inclined to the horizon than the faces M.m., as are the faces beneath on the basal plate. Since the drawing was made the crystal has been measured by Mr. Miers. The results are given at the end of the paper.

Fig. 19.—I have seen only one example of this manner of two crystals growing together. It is water-clear and free from cleavage cracks. A fine line is seen where the crystals join, but it is not more marked than is seen in many twin crystals. Such a combination would be formed by the simultaneous growth of two crystals exactly alike, one turned 180° around its axis of symmetry. One face on each crystal has not been developed, or is so small that it cannot be seen. If present it must be less than the 20,000th of an inch. I do not know what face it is which appears in the lower right-hand corner. Magnified about 130 times: drawn by the help of the camera lucida.

Figs. 20 and 21.—These represent a common form of grouping. The curved faces are generally due to the setting back of plates, but in many cases, especially in parts of fig. 21, the surface looks like a polished curve. The individuals are nearly always separated by a longer plate,

which is often also broader, and, as a rule, all have differently shaped basal sections.

Fig. 22.—A crystal like fig. 9, to which a crystal resembling that of fig. 8 is adherent, with a plate between them.

Fig. 23.—A crystal, the bottom part of which is irregularly developed, the sides are in part step-like and show here and there partially developed cleavage planes running into the crystal from a step. Many polished curves exist on each side.

Fig. 24.—A water-clear crystal, except that near the base where it is regularly developed there are two cleavage-planes. All the lines are gently curved, reminding one of the appearance of many crystals of gypsum. A few steps are to be seen on the upper part of the side faces. The last five figures are magnified about 130 times.

Fig. 25.—An illustration of the unsymmetrical manner in which many crystals are developed, so far as the M.m. and N.n. faces are concerned. It is of uniform thickness, and symmetrically developed at the top. It is adherent to a step-like base. It shows only one partial cleavage-plane. The right-hand shows a curved surface made up of steps so close together that they are here only roughly represented. It would be possible to focus through them and see scratches on the glass slip. This would not be possible on the opposite side, which therefore I think are true planes, more inclined than the ordinary M.m. faces. Magnified about 150 times. Drawn by eye as the crystal did not lie flat.

It will be seen that all the preceding crystals are of pyramidal form, so far as their sides are concerned, whilst the front and back faces are parallel. I spent much time in trying to find out what the crystal would do if the tapering growth continued till the clinopinacoid ran out to a point. I have found only five crystals continued so far upwards, and in four of these cases the crystal stopped exactly at the point of the clinopinacoid. In only one instance have I seen the M.m. and N.n. faces developed beyond the clinopinacoid, and they did not extend to the apex, but were terminated by a small basal plane. In two cases the basal plane appeared, on which was placed a miniature crystal resembling the larger lower crystal. The other two crystals are illustrated in the following figures.

Figs. 26 and 27.—Two views of the same crystal drawn by eye. It will be seen that the M.m. faces are cut off by what look like two pyramid faces, as in fig. 9, a small basal plane terminating the crystal.

Fig. 28.—This crystal puzzled me for long. The apex is a fine line. It would be formed by the continuation upwards of a crystal somewhat

like fig. 4, if it were so proportioned that the basal plane seen on the top should be narrowed to a line when the edges of the clinopinacoid meet in a point. For long I thought that two faces had been suppressed, or were represented only by lines too small to see, but I have since been able so to illuminate the crystal as to see a line of light on the front edge and another on the back edge, which must come from very minute faces. The N.n. faces are very irregular, being in parts made up of steps indicated in the drawing by a few lines and of curves. The crystal shows only a few partial cleavage-planes, represented by dotted lines on the further clinopinacoid. It is drawn by the help of the camera lucida as seen lying on the field of the microscope with its base resting on another crystal, and therefore slightly inclined towards the observer. Magnified about 130 times.

The crystals from which the preceding 28 figures were drawn represent the larger crystals of kaolinite from Anglesey. They were separated from the bulk, consisting of thin scales, by placing some of it in a tube full of water. The tube was about 3 feet long. When all had settled to the bottom of the tube it was inverted in a saucer of water, in which were several watch-glasses so arranged that the tube could be moved from one to the other. The largest crystals of course arrived first, and were received in a watch-glass. They were accompanied by a few small doubly terminated crystals of quartz and small groups of rhombs of calcite or dolomite. By moving the tube to watch-glass after watch-glass a rough separation was thus effected. The smallest crystals and thinnest flakes, all quite perfect, were received in the last watch-glass. Many of the flakes were bent, but did not seem to cleave in any particular direction. The small solid crystals visible under a magnification of 250 diameters, were found, under higher powers, to resemble exactly the preceding drawings; but it was noticed that the clinopinacoids in the small crystals are frequently set back in steps and clinodomes sometimes developed. This seems more general in the variety of kaolinite recently described by Reusch, from the National Belle Mine, one or two slides of which I have seen, and from which I have made the four following drawings.

Fig. 29.—A crystal in Canada balsam lying on its base looked down upon from above, extinguishing between crossed nicols when the edges of the clinopinacoid are parallel to either cross wire accurately set. The crystal the converse of fig. 6. It has the base hexagonal and the top rhombidal. Magnified about 130 times, and drawn by means of the camera lucida.

Fig. 30.—The same crystal further magnified, drawn by eye to show

the triangular faces. The inclination of the M.m. and N.n. faces is not intended to represent the true inclination, which cannot be got owing to the crystal being mounted in Canada balsam and lying on its basal plane.

Fig. 31.—A crystal in air. From this it appears that one face of the clinopinacoid is gathered in upwards by steps.

Fig. 32.—Another crystal in air, showing both faces of the clinopinacoid gathered in upwards by steps, looking like clinodomes till a high power is used.

In the kaolinite from the National Belle Mine, Colorado, many of the smaller crystals show faces which appear to be, and I think are, true clinodomes; and this is also the case in the Anglesey kaolinite. In the latter I found one of the larger crystals, showing what seemed to be true clinodomes, but I lost the crystal in trying to mount it for measurement.

Fig. 33.—When the preceding drawings were made I thought such small crystals could not be measured by the reflecting goniometer, but as Mr. Miers thought it might be possible to do so, I gave him one or two mounted crystals, and have received from him the following measurements from one of them :—

cb = 90° 0
bm = 60° 16′
bn = 60° 46′
cm = 84° 16′
cn = 78° 10′

Fig. 34.—Mr. Miers was able to remount another crystal in five different positions, from which he obtained the following measurements :—

Measured.	Limits.
cb = 90° 0′	89° 52′ – 90° 5′
bm = 60° 17′	60° 16′ – 60° 19′
bn = 60° 44′	60° 42′ – 60° 47′
cm = 84° 5′	
cn = 78° 8′	
cμ = 75° 53′	
cφ = 60° 24′	62° 23′
cθ = 70° 19′	73° 28′

Mr. Miers says "cM as measured is from 75° 20′ to 82° 57′, so that "it is not equal to cm: this I imagine is due to its step-like structure, "since in another crystal cm = 84° 48′ or 83° 53′ } c a bent face, giving
" cM = 85° 3′ or 83° 59′ } two images,
"showing that the two angles are really equal. In the present crystal "cn = cN = 78° 8′."

Giving the faces the following symbols :—

$$b = \infty \breve{P} \infty = 010$$
$$mM = \infty P = 110$$
$$nN = +P = \bar{1}11$$
$$c = OP = 001$$

The axial angle is $\beta = 83° 11'$

$$a : b : c = 0{\cdot}5748 : 1 : 4{\cdot}7267.$$

These measurements establish the crystalline form of kaolinite with considerable accuracy, since the faces are very perfect.

As I had not seen the planes ϕ θ in a microscope very well adapted to show such planes, though not to measure their angles, I asked Mr. Miers whether his goniometer enabled him to locate the planes, as has been done in the diagrams (figs. 33 and 34), or whether the planes, if present, might not be spread over the whole surfaces on the edges of minute step-like plates or otherwise. Mr. Miers replied to this effect :—"I got fair images corresponding to such planes, but the magnifying power of my goniometer does not enable me to see from what part of the crystal they come. The important thing is that if there are genuine faces below nN they are certainly not parallel to mM." It must therefore be borne in mind that the faces $\phi\theta$ shown in fig. 34 are intended only to indicate such reflections. Had these faces had anything like the relative size of those shown in the diagram, they would easily have been seen in the microscope employed. They must be regarded as doubtful.

Referring again to fig. 18, Mr. Miers says his measurements are as follows :—

"From upper basal plane (c in other drawings) to the front central triangular face (orthopinacoid), 82° 5′.

"From upper basal plane to nearest triangular side face, 52° 1′ approximately.

"From upper basal plane to back N face, 78° 9′.

"Other faces did not give good reflections.

"The measured angle, 82° 5′, is about one degree different from the calculated angle β, 83° 11′, but the face was striated and the reading not very reliable. When the crystal was cleaned and remounted, the angle obtained was 82° 15′."

I have to thank the Director-General of the Geological Survey for the use of the Petrological Laboratory in this investigation, which sprang from one on the composition of the sands and clays of the London basin. During the progress of the same I examined a number of substances containing kaolinite, or supposed to do so. One sample which I received from a

friend was supposed to contain the mineral in definite crystals. It came originally from Tremadoc in North Wales, and consisted partly of small six-sided plates, somewhat resembling kaolinite, and partly of ram's-horn-looking aggregations. When seen in bulk it had a pale leek-green colour. Under the microscope it was found to be uniaxial or nearly so. Thinking it might be a small-angled mineral related to kaolinite as biotite is to muscovite, I analysed it. Under the microscope it seemed a nearly pure mineral. Its composition was found to be as follows:—

Silica	26·03
Alumina	17·87
Iron protoxide	34·84
Magnesia	8·58
Water[1]	12·90
	100·22

It contained traces of manganese and lime. I reported it as ripidolite, with an unusually high percentage of iron and low percentage of magnesia. My friend said he had been induced to think it contained kaolinite from the residue it left after being boiled in hydrochloric acid. I accordingly boiled it for many hours in that acid and obtained about 17 per cent. of insoluble residue, exactly resembling the original mineral in form, but white when seen in bulk.

The plates no longer showed the uniaxial figure in convergent light, but the ram's-horn-looking aggregations whilst moist showed faint depolarising effects as they were turned on the field of the microscope, being dark when the longer axis of the aggregations were parallel to the cross wires. This residue was found to consist of pure silica. It retained even the markings on the original crystals. It was more opaque in air, but in Canada balsam it could not be distinguished from the ripidolite from which it arose except by its action on convergent polarised light. Formed under favourable circumstances in nature where the residue could harden, it would, I think, form tridymite, the untwinned varieties of which, so far as I can see, it exactly resembles in form, composition, and optical properties, differing only in its lesser cohesion. It is not altered by heating to redness.

[1] The water was estimated by heating a weighed portion of the mineral to redness in the air, and continuing the calcination till the weight was unchanged. During this the iron was converted into peroxide, and the increased weight arising therefrom was deducted from that of the residue and added to the loss. This method of determining the water is not quite correct, but I had only a small amount of mineral to work upon.

I examined specimens of ripidolite from New Rosewarne Mine, Cornwall, and found it left the silica in like manner of snow-like whiteness, and in flakes of brilliant lustre, but less transparent than the original mineral. I have on previous occasions observed silica, and also titanic acid, remain as pseudo-morphic residues after the action of acids on several minerals.

The silica left by the action of hydrochloric acid on the ripidolite (ogcoite) from the Val Maggia, Switzerland, is, when thin flakes of the mineral have been employed, so coherent and transparent in parts, that it is difficult to believe about three-fourths of the constituents of the mineral have been removed. That it really is pure silica is shown by the fact that it is unaltered by heating to redness in air, the mineral under such conditions becoming deep brown; that it dissolves in a hot solution of carbonate of potash and volatilises when evaporated with hydrofluoric acid. The decomposed scales of the mineral are generally striated by lines indicating, I suppose, planes of easiest solution, or it may be of shrinkage, but in many parts the residue looks like muscovite, the step-shaped edges of the original mineral being perfectly retained by the transparent pseudomorphic residue, which is more lustrous than the original mineral.

That minerals of the ripidolite class thus leave their silica, in part at least, when decomposed, seems worth notice, as such residues may enter into the composition of many clays.

Note on the Occurrence of Celestite containing nearly fourteen per cent. of Free Sulphur.

By H. J. Johnston-Lavis, M.D., F.G.S., &c.
(Communicated by F. W. Rudler, F.G.S.)

[Read January 10th, 1888.]

THE mechanical inclusion of foreign substances in crystals during their formation is of such common occurrence that it might appear superfluous to record further examples, were it not that the present case is a somewhat unique one. All mineralogists are acquainted with the inclusion of sand and clay in selenite, celestite, and calcite, of which the Fontainebleau limestone is a striking example. Delesse found the crystals of calcite from that locality to contain 57 per cent. of sand, and to have a sp. gr. of 2·84, whilst the sp. gr. of pure calcite is given by Beudant as 2·721 to 2·723, which demonstrates that the inclusion of the heavier quartz grains raises the sp. gr. of the impure crystals.

The specimen of celestite to be described comes from one of the mines across the valley and railway close to Girgenti, Sicily. When I collected it search was made for more examples, but without success, and as at the time I was not quite clear as to the cause of the yellow colour of the crystals, my search was not perhaps quite as careful and prolonged as it might have been. Since the autumn of 1882, when the specimen was found, up to the present time, I have written to various friends in Sicily who are interested in mineralogy, but without being able to obtain further examples.

The specimen is about two-thirds the size of one's hand. The matrix is the common dark grey limestone of the sulphur mines. This is coated with a layer of compact crystalline sulphur of deep orange colour, which becomes opaque and granular towards one side. The sulphur is in part covered with small scalenohedrons of calcite. Upon the sulphur and calcite are implanted the celestite crystals, which vary from one to two centimetres long and from one to three millimetres broad. The crystals are thus particularly long and thin, tending to become acicular, but they are remarkably well formed and terminated. The prismatic faces e^1 are very well developed, almost, and in many cases entirely, to the exclusion of p. The pyramidal faces m predominate and often exclude a^2. Other planes I have been unable to detect. A long prism may be in part perfectly transparent and limpid, and another part may be quite opaque and of a dirty

non-yellow colour, with the line of demarcation well defined between e two parts. The surface of the prism, both of the pure and the impure rts, is equally brilliant, and on examination with a goniometer no difference inclination of one face upon another can be detected.

Three different yellow-coloured crystals were very finely pulverised in agate mortar, and transferred to a small covered porcelain crucible eviously heated to redness and weighed. The powder was dried over lphuric acid for 48 hours and then weighed. Heat was carefully applied d gradually raised until all the sulphur was driven off. After cooling, the psule and contents were again weighed, and gave the following result:—

Sulphur (and loss)	13·69
Celestite	86·31
	100·00

The loss in heating is counted as sulphur, but possibly, though im-bably, may have in small part consisted of some other substance.

These three crystals were previously used for the determination of their gr. by weighing in air and distilled water. The average of various trials 3·739, with insignificant differences between the observations. The erage of seven data of different authors places the sp. gr. of celestite at 539, the lowest of these seven being 3·92. These facts afford us idence that the included sulphur lowers the sp. gr. of its host in the same y that the denser quartz grains raise that of the impure crystals of cite.

The next point was to examine the crystals microscopically, an investi-ion that presented two important difficulties. Celestite, from its great gility and possibly from internal tension, does not permit one to obtain a ooth (microscopical) face, and next it is necessary to mount and examine sections immediately, as the Canada balsam soon dissolves out all the phur. This latter substance occurs as minute octahedral crystals veloped in the celestite their distribution being independent of planes of stalline growth, as they adopt an arborescent or dendritic arrangement. s may be well seen at the limit of the pure and impure celestite by ploying reflected light.

t would appear that part of the sulphur crystals and celestite formed ultaneously, and that the latter was compelled to include the sulphur ins as its crystals grew in size. This is further indicated by the fact t where clear parts of the prism occur is where it projects some con-erable distance from the surface, and where the sulphur has been ered with calcite; there the celestite is as clear as crystal.

Notes on Hornblende as a Rock-forming Mineral.

By Alfred Harker, M.A., F.G.S., Fellow of St. John's College, Cambridge.

[Read January 10th, 1888.]

THE part played by hornblende (*i.e.* the monoclinic amphiboles) in the constitution of rocks, and the relation of that mineral to augite (including all the monoclinic pyroxenes), are subjects which, in recent years, have occupied much attention. It has been recognised that the early notions of paragenesis cannot be applied, without many reservations, to rock-forming minerals. Some petrologists have gone so far as to suppose that augite and hornblende "are two different crystallographic forms of essentially the same molecule, of which the former is most stable at high, the latter at ordinary temperatures."[1] If this view receives any extensive confirmation, the well-known conversion of augite into hornblende must be regarded as a purely paramorphic change due to altered conditions. The chemical identity of the augite and its resulting hornblende is, however, to be proved or disproved in any given case, and meanwhile the analyses seem to indicate a fairly consistent difference of composition between the two minerals, so that the change in question is rather a pseudomorphic than a paramorphic one.

Further, petrologists are coming to admit that neither colour nor internal structure affords a certain criterion to discriminate between original and secondary hornblende. In particular, hornblende produced by the pseudomorphic alteration of pyroxene may be brown, compact, and well cleaved, so as to be identical in appearance with original hornblende crystals in the same slide: the two can be distinguished only by their mode of occurrence and their relation to adjacent pyroxenic minerals.

The various modes of occurrence of hornblende are well illustrated by the "hornblende-diabases" &c. of Western Caernarvonshire and Anglesey, in which, excluding fibrous and actinolitic forms of amphibole, we find the following varieties, two or three of them often being seen in the same thin section:—

(i.) Original hornblende in idiomorphic crystals.—This shows the usual

[1] G. H. Williams, *Amer. Journ. Sci.*, Vol. XXVIII. p. 259, 1884. See also "The Gabbros and Associated Hornblendic Rocks of Baltimore," by the same author, *Bull. U.S. Geol. Surv.*, No. 28, 1886.

ismatic cleavage, and more rarely one parallel to the clinopinacoid. It has
e normal brown colour, with the ordinary pleochroism, but sometimes
sses gradually into greenish or colourless hornblende in a manner
ggestive of subsequent alteration. The crystals rarely show terminal
anes: the cross-section is bounded by the prism-faces, with often the
nopinacoid and sometimes the orthopinacoid.

(ii.) Original ophitic plates of hornblende with its other characters as
fore.—It is not always possible to distinguish these with certainty from
eudomorphic hornblende completely replacing plates of augite. Some-
nes, however, they are seen to include imperfect crystals and rounded
ains of augite without any crystallographic relation between the two
inerals. They also enclose crystals of earlier-formed hornblende.
iginal hornblende is very rarely found in these rocks as a definite inclusion
plates of augite.

(iii.) Original enlargement of hornblende crystals.—This is a bright
ass-green variety, forming an addition to idiomorphic crystals of brown
rnblende, and in crystalline continuity with them. From its always
esenting good crystal faces, it appears to have been formed prior to the
al consolidation of the rock. It grows chiefly upon the clinopinacoidal
es of the brown crystals, and often entirely obliterates those planes.

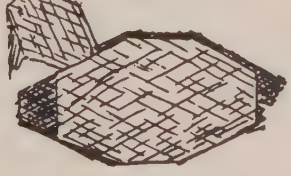

Fig. 1.

. 1 shows two cross-sections of brown hornblende thus augmented by
en hornblende-substance, from Lys-einion, Anglesey.

iv.) Complementary (*ergänzende*[1]) hornblende, also original.—This is
rowth of brown hornblende surrounding a nucleus or kernel of augite,
sometimes forming a partial border on the edge of an augite plate. The
minerals have their orthopinacoids and clinopinacoids parallel, differing
s from the hornblende which merely includes grains of augite. The
ndary of the augite nucleus, though often less regular than that of
e included grains, is never so ragged as that of an augite core sur-
nded by pseudomorphic hornblende. A section of the picrite of

[1] *Rohrbach, Tscherm. Min. u. Petr. Mitth.* (*N.F.*) Vol. VII. p. 24, 1886.

Penarfynydd shows a plate of augite surrounded by complementary hornblende, with rounded olivine grains, the earliest product of consolidation.

(v.) Pseudomorphic or perimorphic ("paramorphic") hornblende.—The amphibolisation of the augite takes places either in capricious patches, or in streaks or shreds following the cleavage; but very often the process begins at the exterior of the crystal or plate, and extends inward. This marginal alteration has been styled perimorphism. When well-formed crystals of augite have been altered in this manner, the secondary nature of the hornblende is very apparent. In the case of shapeless plates, the origin of the hornblende is usually indicated by the very irregular and intricate boundary which it presents to the remaining core of augite. Further, it often happens that several isolated cores or patches of augite remain, which, from their optical continuity, are seen to have formed part of one original augite plate. This cannot be the case where augite is embedded in complementary hornblende. A plate of pseudomorphic hornblende and the remains of the augite from which it has been derived are related in such a way that the clinopinacoid and orthopinacoid are common to the two minerals; but in some cases the two are in reverse position to one another, the extinction-angles in a clinopinacoidal section being about 40° for the augite and 20° for the hornblende on the same side of the vertical axis.

(vi.) Secondary enlargement of hornblende crystals.—This is a later growth of amphibole, sometimes green, but usually colourless, forming an extension to crystals or plates of hornblende, with crystalline continuity. It gives rather higher polarisation-tints and a very slightly wider extinction-angle than the original mineral. It is certainly posterior to the consolidation of the rock, and may often be seen to occupy the place of felspar, olivine, or some other original mineral, at the expense of which it is in part formed. This secondary hornblende is usually a narrow fringe with a ragged edge; at other times it extends so as to fill up the space between the crystal from which it grows and some neighbouring crystal. Again, the interstices between two or three original crystals may be filled by colourless hornblende, which between crossed nicols is seen to consist of portions belonging to the several adjacent crystals. The new growth is much more apt to be developed on the ends than at the sides of the original crystals.

(vii.) Hornblende as a secondary enlargement of augite.—F. Becke[1] and Van Hise,[2] who first described the secondary enlargement of horn-

[1] *Tscherm. Min. u. Petr. Mitth.* Vol. V. Part II.; 1883.

[2] *Amer. Jour. Sci.* (3) Vol. XXXIII. p. 385; 1887.

lende crystals, have also pointed out the growth of a similar fringe of ornblende around augite. Such a growth is found, though perhaps not ery frequently, in the Welsh diabases.

It is to be noticed that the original hornblende constituting the idiomorphic crystals, the proper ophitic plates, and the crystals and ophitic lates complementary to augite nuclei, is all of the compact brown variety amed, not very appropriately, basaltic. The hornblende pseudomorphic fter augite, though sometimes rather paler, is usually identical in appearance with the first-mentioned brown hornblende. The green hornlende of "original enlargement" was deposited after the magma had een altered in composition by the abstraction of the earlier constituents; nd the very pale or colourless hornblende of "secondary enlargement" ust have grown mainly at the expense of other minerals, mostly poor iron. In fact, this colourless fringe, although continuous with original ornblende or augite, is to be regarded as a secondary product derived rom the felspar and olivine of the rock.

Abstracts.

Die Serpentin-und Amphibolgesteine nördlich von Marienbad in Böhmen (Min. und Pet. Mitth. Bd. IX. 1887, pp. 89-144).

The largest mass of serpentine in Bohemia occurs in the crystalline schists immediately to the north of the watering-place Marienbad. The gneiss-formation, which, with its included masses of granite, occupies the larger part of N.W. Bohemia to the west of Carlsbad, and passes to the north into the crystalline schists of the Erzgebirge, contains numerous interstratified masses of extremely variable hornblende and garnetiferous schists, which latter have attained in the region of Marienbad to a very extensive development, and are here intimately associated with serpentine. The serpentine, with the exception of one mass several miles in length, occurs in isolated patches scattered over an area 5 × 10 miles in extent. It is probable that these patches are the remains of a continuous sheet of serpentine once overlying the schistose rocks, and now mostly removed by erosion.

The serpentine of this region, the description of which occupies the first part of the paper, presents a very varied external appearance, due in large part to material differences in the rocks from which it has been derived. The original ingredients in many cases still remaining, as well as the structure, point to a peridotite as the mother-rock. Olivine, which is always present or at least indicated by characteristic decomposition products, is accompanied by either enstatite or a light-coloured tremolite, occasionally by both. Where olivine abounded, enstatite gave rise to bastite, and tremolite to two serpentinous products. The first product of decomposition which crystallised out on the edges and along the cleavage planes of the tremolite, shows a very different optical orientation from that replacing the body of the crystal. The latter cannot be distinguished from true bastite. Instead of serpentine, talc has been formed at the expense of both tremolite and enstatite, wherever olivine was not abundant.

Another almost universal secondary product is chlorite, which uniformly shows positive characters when in association with olivine or with olivine-serpentine. In places where talc is abundant (that is where olivine is absent), a negative chlorite either replaces the positive chlorite, or surrounds

e same like a mantle. In one rock an almost colourless chlorite shows very distinct plagioclase-like twinning, and would easily be mistaken r this mineral. It is distinctly monoclinic. A further very common condary product is tremolite in minute acicular crystals.

Among the schistose rocks described, the most interesting are:—1. A isite-amphibolite in which the elongation of the zoisite crystals plays important part in producing the schistose structure. 2. Kelyphite-logite. The term kelyphite has been applied to this very beautiful ck on account of the dark green bands surrounding the sharply defined rnets. This zonal growth, which has apparently not been formed at e expense of the garnets, consists of hornblende and some plagioclase. ne groundmass is an exceedingly fine micro-pegmatoidal intergrowth of rnblende and pyroxene, or omphacite. Other frequent ingredients e zoisite, quartz, rutile, apatite, and in one case disthene. 3. A beau-fully banded and contorted pyroxene-amphibole-schist.

Although the serpentine shows no intermediate links connecting it with e amphibolite, there is still no evidence that it is of later origin than e great mass of surrounding schistose rocks. HORACE B. PATTON.

R. BRAUNS (*Neues Jahrbuch, 1887, I. p. 138*) has attempted to solve e question whether there is any variation in the angles of doubly-refracting bic crystals, as compared with those which are isotropic; whether the stortion of the molecular structure which is assumed to be the cause of e optical anomalies of such crystals is accompanied by any corresponding stortion in the external form. The measurement of a large number of ry perfect crystals of lead nitrate, ammonium alum, and spinel, has nvinced him that such is not the case, but that the isotropic crystals any of these substances are subject to the same angular variations as e doubly-refracting crystals of the same substance. Certain irregularities the angles of lead nitrate, indicating that the octahedron angles over e edges are generally too large, while those over the corners are too all, are attributed by the author to the action of gravity. H. A. M.

O. MÜGGE (*Neues Jahrbuch, 1887, I. p. 195*) discusses the flexibility the well-known Delhi sandstone, and comes to a conclusion similar to at which has been previously suggested by Quenstedt.

From a microscopic examination the author finds that this sandstone ntains far less clayey material than other sandstones, and that it consists actically of quartz grains which have not the usual rounded shape, but e of irregular outline; the consequence is that they dovetail into one nother, and give to the mass that cohesion which enables it to bear re-

peated flexure without falling to pieces. It appears that the grains have been increased by deposition of secondary quartz after the disappearance of the original cementing material. H. A. M.

A New Mineral. Cristobalite.—Vom Rath has found minute white octahedral crystals accompanying the tridymite from San Cristobal, Pachuca, Mexico, which consist practically of silica. An analysis (made upon 0·081 gram.) gave 91 per cent. of silica and 6 per cent. of oxide of iron and alumina. The crystals are partly simple octahedra and partly spinel twins, and they frequently exhibit a skeletal structure. They must either be a cubic form of silica, or pseudomorphs after some unknown cubic mineral; it is, however, scarcely possible that they can be pseudomorphs after spinel or faujasite, which seem the only possible minerals; and an optical examination by Prof. Max Bauer shows that the crystals have an isotropic hatch in the centre, which gradually passes into an anisotropic border; the latter is ascribed to the anomalous double refraction common in cubic minerals; the optical characters do not support the view that the crystals are pseudomorphs *(Neues Jahrbuch, 1887 (1), p. 198).* H. A. M.

New mode of occurrence of Germanium.—This new element, which was recently discovered by Prof. C. Winkler in the mineral Argyrodite from Freiberg, has now been detected by G. Krüss *(Berichte der deutschen chemischen Gesellschaft XXI. 1887, p. 131)* in Euxenite (titanate and niobate of yttrium and uranium). The proportion of Germanium is only one-tenth per cent., but the discovery is of theoretical interest as indicating that this element may replace titanium; it is, therefore, not improbable that it may be found in other titanium minerals. H. A. M.

Des Cloizeaux *(Bull. Soc. Min. de France, VII. (1884), p. 72)* finds that mangano-calcite has optical characters which indicate that the mineral belongs to the anorthic system, the figure seen in the polariscope through a cleavage plate exhibiting both inclined and crossed dispersion. An analysis by Winkler shows that the mineral is practically:—

SiO_2	...	...	...	...	51·58
MnO	...	...	...	...	40·69
H_2O	...	...	...	...	7·73

It must, therefore, be removed from the carbonates, and placed among the silicates.

An examination by Des Cloizeaux and Bertrand of bustamite from Longban shows this mineral to be in its optical characters quite distinct from the bustamite of Schemnitz, and also from paisbergite, with which it is crystallographically almost identical. H. A. M.

Coward del. et lith.

Mirtern Bros. imp.

BEMROSE & SONS, PHOTO-TINT. LONDON & DERBY.

To illustrate Major-General McMahon's Paper on "The Polysynthetic ructure of some Porphyritic Quartz Crystals in a Quartz-Felsite."

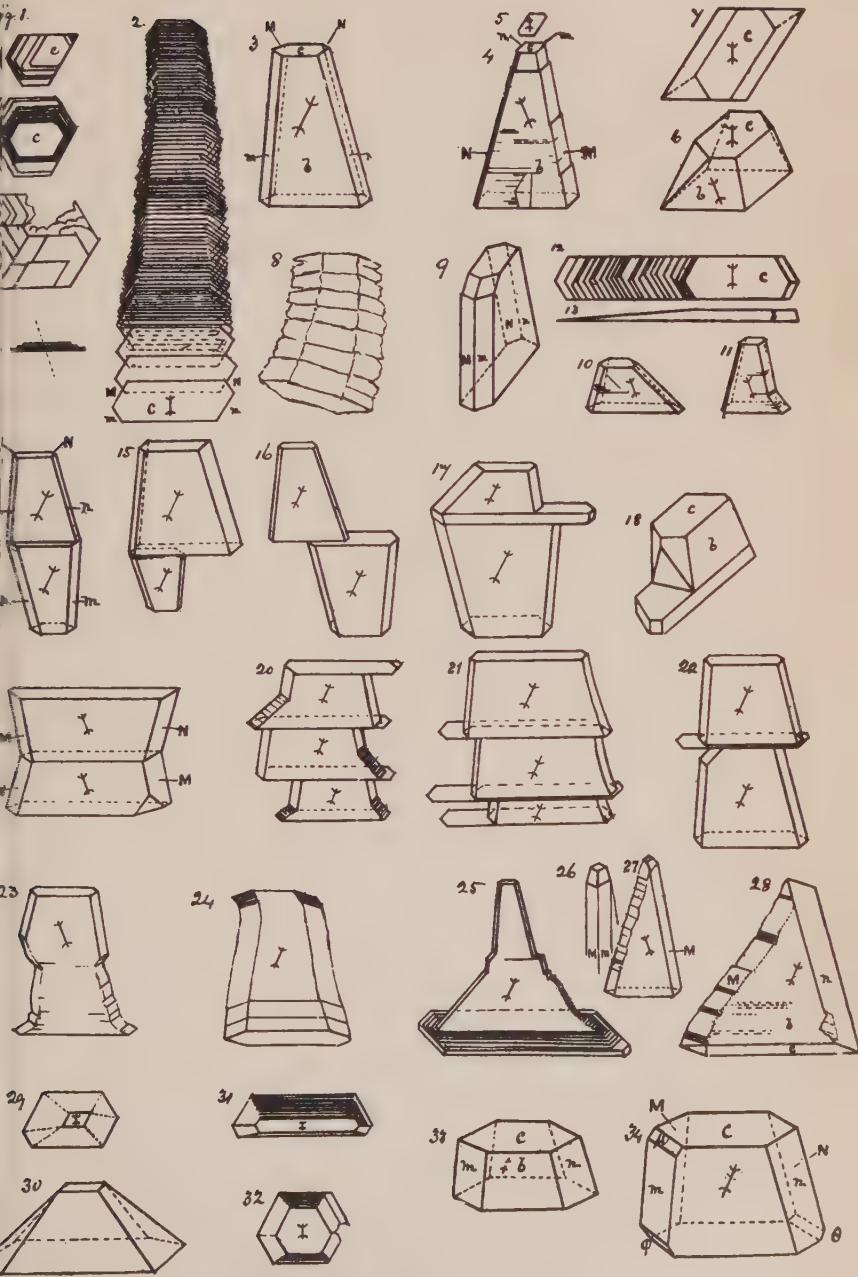
fig. 1.
2.
3
4
5
7
6
8
9
12
13
10
11
15
16
17
18
20
21
22
23
24
25
26
27
28
29
31
33
34
30
32
M
N
c
b
m
n
θ

CONTENTS OF No. 36.

		PAGE
JUDD.	On the Development of a Lamellar Structure in Quartz-crystals by Mechanical Means	1
MCMAHON.	On the Polysynthetic Structure of some Porphyritic Quartz-crystals in a Quartz-felsite	10
DICK.	On Kaolinite	15
JOHNSTON-LAVIS.	Note on the Occurrence of Celestite containing nearly fourteen per cent. of Free Sulphur	28
HARKER.	Notes on Hornblende as a Rock-forming Mineral	30
	Abstracts	34
	Index to Vol. VII.	

CONTENTS OF No. 35.

FLETCHER.	On a Meteoric Iron seen to fall in the District of Nejed, Central Arabia, in the year 1863	179
FLETCHER.	On a Meteoric Iron (containing Crystallised Chromite) found about the year 1880, in Greenbrier County, West Virginia, U.S.A.	185
FLETCHER.	On Crystals of Cuprite and Cerussite resulting from the slow alteration of buried Coins	187
		189
FLETCHER.	On the Crystalline Form of Creatine	191
BONNEY.	On a Variety of Glaucophane from the Val Chisone (Cottian Alps)	194
JUDD.	On the Discovery of Leucite in Australia	196
MIERS & PRIOR.	On a Specimen of Proustite containing Antimony	201
TEALL.	On the Occurrence of Rutile-needles in Clays	205
COLLINS.	On the Nature and Origin of Clays: the Composition of Kaolinite	215
THOMSON.	Note on the occurrence of what may prove to be a New Mineral Resin	216
GYLLING.	Obituary Notice of E. H. Furuhjelm	238
MIERS.	Index to Mineralogical Papers, 1886	256-260
MIERS.	" " " 1883 to 1885 (continued)	218
	Abstracts	

ORIGINALLY PRINTED IN GREAT BRITAIN BY MESSRS. WILLIAMS AND STRAHAM, LONDON. REPRINTED OFFSET LITHO BY BIDDLES LTD., THE CITY PRESS, GUILDFORD, SURREY